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PROCEDURE AND INSTRUCTION GUIDE FOR ARTIFICIAL REVEGETATION AT THE ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

by
A.C. Hull, Jr.

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by
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PROCEDURE AND INSTRUCTION GUIDE FOR ARTIFICIAL REVEGETATION AT THE ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION[1/]

by
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FOREWORD

This procedure outline is to help guide the beginning phases of the seeding program so that they will be correlated with the later phases and with the long-time basic research program.

Considerable emphasis is put on uniformity. This is not to stifle initiative, but an effort to get studies within the same area and from different areas uniform enough so that results can be easily summarized to give a complete picture of reseeding by species, methods, areas, or regions. Uniformity in seeding and collecting data between years and between areas is necessary for orderly analysis which leads to publications and other presentations.

This is a guide only and as better procedures are found they will be made a part of the over-all regional reseeding program. The present guide covers the following: (1) Locating studies; (2) Types of studies and procedure in studies; (3) Methods of collecting data; and (4) Reseeding methodology.

LOCATING STUDIES

Basic and long-time studies should be centralized where they are accessible for work and demonstration. Present research center headquarters or experimental forests have equipment, and seeding work can be conducted from these centers with a minimum of travel and expense. At such central locations, seeding work can also be correlated with grazing management and forest influences.

For a complete program at each work area, studies would be initiated at all types in need of reseeding. Under this ideal set-up, each work area would thus be a unit in which species, methods of seeding, site factors, and management of seeded grasses had been determined for all major vegetation types. By combining results, a comprehensive regional reseeding picture can be obtained for each type, species, or method. Uniformity of studies will make regional analysis easier and more reliable. Where all studies are laid out in a single route of travel from low to high elevations, it is better for work and for demonstration.

Studies may also be established away from centralized areas. Such studies may be to gather new information, substantiate results from centralized areas, or for cooperation. Accessibility should be considered in these studies.

1/ Maintained by U. S. Department of Agriculture, Forest Service, in cooperation with Colorado A & M College, Fort Collins, Colorado.

TYPES OF STUDIES AND PROCEDURES IN STUDIES

Types of studies should be as similar as conditions throughout the region permit. For pure research, fundamental studies are probably best. However, the need for increased forage and watershed protection is urgent and research must get some immediate answers. It is, therefore, necessary to conduct fundamental and applied studies concurrently on the various phases of reseeding.

Reseeding research is divided into four line projects: (1) Species; (2) Methods; (3) Site factors; (4) Management of seeded areas. These four divisions will be used in the following discussion.

SPECIES

This phase consists of a search for species to be tested and the actual testing of these species. Results from other stations and agencies will be helpful in determining species and strains which might be tried. Before testing, the researcher should know the following: (1) the ecology and growing conditions of the area, with the possibilities for improvement of site and plant cover; (2) Growth requirements of the species; and (3) purpose of the seeding. This knowledge will then help determine species for testing. It is useless to test a species when growth requirements and growing conditions do not match.

Past reseeding has been mostly with introduced grasses. More attention should be given to native plants. Promising legumes should be used where possible to take advantage of their nitrogen-fixing bacteria. Browse is needed on winter game ranges. Shrubs are needed for erosion control.

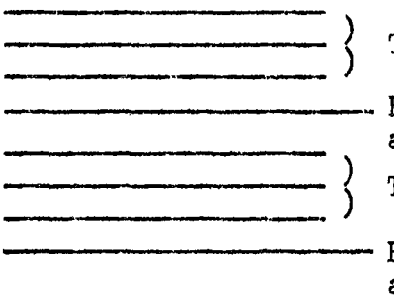
Species trials are subdivided into six groups: row plots, range plots, pilot tests, field plantings, strain tests, and mixtures.

Row plots (nurseries) are a screen to test adaptability of species to soil and climatic conditions when competition is removed by weeding. Major row tests should be correlated between work areas and with other regions. The natural tendency is to have too many row tests and to include too many species. The growth conditions on the areas and the growth requirements of the species should be considered and both the number of row tests and species within row tests kept to a minimum. Funds permitting, there may be one small row test in each vegetation type in which work is being done at each work area.

Row plots may be as small as three rows, 10 feet long, and up to twice this size if space and labor for maintenance allows. Rows should be spaced 12 to 36 inches so that most weeding can be done with garden or farm tractors. Shrubs should usually be in 36-inch rows. Rate of seeding should be high enough for good stands. Season and depth of seeding should be as near optimum as possible. Two to three replications, with each replicate in a separate block, are usually sufficient. Data should be collected mostly by plot ratings (see Appendix H).

Comparisons between strains or species are more direct if strains of a species, species with like growth habits, or species which will be used for the same purpose, are randomized within sub-blocks rather than randomized throughout the entire block. This will allow direct comparison of species which are going to be used for any purpose. Species which fail can be planted on the same plot in subsequent years. In laying out the test area, provision should be made for the addition of new species and strains in adjacent blocks in future years.

To cut down mixing of species, minimize border effect, and give each species equal competitive opportunities; a standard border species of sheep fescue or some other low-growing bunchgrass with a heavy root system may be seeded in a single row between plots as diagrammed below:


Three rows of species "A" spaced 18 inches apart
Border species spaced 18 inches from species "A" and "B"
Three rows of species "B" spaced 18 inches apart
Border species spaced 18 inches from species "B" and "C"

When species in row plots become mixed, a new plot area may be established and the old plots be left without weeding. This is a quick way to find which species cannot compete with invading plants. This natural elimination cuts down the number of species to be tested in range plots. This saving alone compensates for establishing new row plots, and should be considered in the original design.

Range plots are a further test of species which do well in row plots. They should be planted at the season and by methods used in seeding large areas. As there is no weeding, the seeded plants must compete with weedy plants which come in following planting.

From 5 to 30 species are usually tested with each species seeded once in each of two or more replicate blocks. Unless we want precise performance data, it is probably better to seed two replications on each of several sites rather than have several replications on one site.

Plots may be any convenient size from 1/200 to 1/10 or more acres. Long, relatively narrow plots are usually easiest to treat. Where a study runs for two or more years, the ease of treatment and the possible plant competition makes it advisable to have a separate block for each year.

Data will be collected by ratings and herbage yields (see Appendix H and I).

Pilot tests and demonstrations are to test recommended species and planting methods on a small scale preparatory to the final field plantings. From 1 to 10 species are usually planted. Plots should be at least 33 x 132 feet and may be up to several acres in size. Data may be collected by plot ratings, herbage yields, or animal days of grazing (see Appendix H and I). These plantings often yield good cost data.

These plots will be of more value for demonstration if they are grazed, cut for hay or seed, and are along traveled roads. Agencies and individuals should be encouraged to seed such plots under research supervision. This helps sell the program and provides training.

Field plantings are the responsibility of action agencies and individuals. However, research should stimulate these plantings, advise proper species and methods, and keep informed on what is being done. As field plantings are made, it may be possible for research to advise or supervise pilot tests of species and methods in connection with the larger area. This will provide information helpful for future plantings. Cost figures can be obtained from field plantings.

Strain tests. It is often stated that grasses are where cereals were 50 years ago; before much improvement work had begun. Plant breeding will be done by the Bureau of Plant Industry. However, stations can assist by testing improved strains and by watching for outstanding strains of native and introduced plants. Improved strains should be used for experimental seedings if they are better than the standard.

Mixtures are desirable on mountains and other areas where sites change considerably in short distances. The station should assemble information on species which do well in simple mixtures. Legumes are valuable additions to mixtures and all promising legumes should be tested. The possibility of seeding species in alternate drill rows for mixtures should be tested. Single species are easier to manage for grazing.

METHODS

Seeding methods vary widely with the area. Work at this and at other stations shows that the following information is needed for effective seedings: (1) How to remove competing vegetation and prepare a good seedbed; (2) Efficient machinery; (3) Seed distribution and depth of seeding; (4) Season of seeding; (5) Rate of seeding; (6) Width of row spacing; (7) Nurse crops; (8) Cost of seeding. These eight items are discussed below:

Seedbed preparation. Competing vegetation must be removed to allow successful establishment of reseeded stands. The method and season of removal will depend upon vegetation, topography, and various other factors.

Controlled burning of sagebrush, juniper, and browse species has been generally successful. Plowing with the wheatland-type and Brushland plows, and heavy offset disks have also been good for brush eradication. Rails and pipe harrows are adapted to some sagebrush areas. Annual and perennial weeds that compete with seeded plants are usually removed by plowing or heavy disking. Spraying with 2,4-D and other chemicals should be tested in weeds, brush, and trees. The advantages and limitations of the various methods vary with vegetation and site conditions. Study is needed on their best use.

Special methods such as mulching, furrowing, summer fallowing, etc. and direct seedings of plants, sod, or woody cuttings, and nurse crops may be necessary to get a cover on some of the more difficult seeding sites and on raw and eroded soils. Time of seedbed preparation needs study as it influences kill of competing vegetation and moisture conservation.

Studies on efficient and inexpensive methods of removing competing vegetation and getting a good stand in all types have high priority because better and cheaper methods will allow successful seedings at a lower cost.

Machinery. Efficient seeding machinery pays off in any seeding program. Large, heavy equipment usually does the best and cheapest job. Although it is not our work to develop new seeding machinery, we may assist by noting machinery which might be used for various reseeding tasks, keeping advised of the work of the Forest Service Range Reseeding Committee, and advising Forest Service Administration of the best machinery.

Seed distribution and covering. Even seed distribution and covering reduces the amount of seed needed for a good stand. Drilling is the best method of even seed distribution and covering. Hand, machine, and airplane broadcasting often provide even distribution but the broadcast seed must be covered.

Seed covering to a uniform depth of 1/4 to 1 inch for most species used in range reseeding has given good results. Until more definite information is available, the small seeds of bluegrass, timothy, and similar species should be covered 1/4 to 1/2 inch deep; crested wheatgrass and similar medium-sized seeds should be covered 1/2 to 1 inch deep; and large seeds may be covered deeper.

Studies are needed to determine optimum planting depth for different seasons, soil types, and soil moisture conditions. If proper seed covering can increase the percent seedling emergence and survival, this will cut down seeding rates and reduce costs. Shallow seed covering in the bottom of deep furrows has given excellent results in other regions and should be tested here.

Season of seeding. The season when seedings are most likely to be successful is largely determined by soil moisture and growing temperatures. Plants establish themselves better if seeded just prior to a month or two of favorable moisture and growing weather. The Intermountain Station recommends mostly fall seeding. However, in this region it is possible that seedings can be made during the spring and summer.

Until definite answers are forthcoming, it appears that the best time for planting is March or October on the Front Range and in south central Wyoming; August at high elevations on the Western Slope; and March or October at low elevations in this area.

To determine proper season of seeding, studies should be located at different elevations at each work area. A complete study would consist of planting two to four adapted species once a month during the growing season for a 5-year period. This study or a streamlined version of this has a high priority and should be initiated immediately.

The cultural operations of season-of-seeding studies are difficult. Where machinery is always available it is usually best to prepare the seedbed just prior to seeding so that all plots will have an equal chance. Where machinery is not always available it is usually best to prepare a seedbed in the fall for all plots to be seeded during the coming year. The summer-fallow effect of this treatment cannot be avoided. Annual weeds help counteract the summer fallowing and plots can be hand weeded on each plot just before seeding. Because of seedbed preparation it is usually best to have each year's treatment in a separate block. This provides a poor test between years, but a good test between seasons within years.

Rate of seeding. Sufficient seed is a "must," but too much seed is costly. In test plantings, enough seed should be used to insure good stands. For this purpose, seeding rates as established by other agencies and stations, and seed size, purity, and germination may be used as guides. (See 1948 USDA Yearbook of Agriculture GRASS, pp. 744-752.) Studies should be started now to show the optimum and the minimum seeding rates of major species for each range type and under different methods of seedbed preparation.

If seeding rates of crested wheatgrass can be cut by 2 pounds per acre, this will decrease the cost of seeding by 60 cents an acre.

Row spacing is closely correlated with seed distribution and rate of seeding. Work in the Intermountain Region shows that drill spacings of from 6 to 12 inches are best for forage production and soil protection and that spacings of 2 to 4 feet are best for seed production. Until studies are initiated, row spacings of 6 to 12 inches should be used.

Row-spacing studies have a fairly high priority as they are needed to show the effect of row spacing upon herbage and seed production, soil protection, and plant survival under drought conditions. At least one study should be initiated in each of the major types in the region.

Nurse crops on arid lands usually take the moisture and prevent the establishment of perennial seedlings. Where wind or water erosion is a problem, nurse crops may be desirable. Because of their limited use, nurse-crop studies are of low priority. Where used, the method of planting in alternate drill rows with the perennial grass should be tried.

Cost of seeding is not a separate study, but cost figures should be obtained wherever possible as a base for seeding recommendations. Most cost figures will come from pilot-test plots and from field plantings. In many cases, comparative cost figures can be obtained from methods studies.

SITE FACTORS

This line project is to obtain information on factors which favor or limit plant growth and thus affect reseeding. Factors of plant growth and site are numerous and varied, and it will be impossible to discuss them in this analysis. Some of the more important for plant growth are: water requirements and drought resistance, soil, temperature, rate of top and root growth at various seasons, and seed germination. Important site factors are: soil moisture, fertility (both inherent and applied), precipitation, temperature, competing vegetation, animals, insects, and disease.

Although studies are needed in all phases of this project, present funds make it necessary to limit work to portions of the four following phases: (1) Growth requirements of reseeded species; (2) site evaluation; (3) the effect of soils and fertility upon stand establishment; and (4) the competitive effects of low-value plants upon reseeded plants. Work on these phases must be general only. As funds are available, these phases should be expanded and the following studies initiated: seed germination, water requirements, drought resistance, temperature, top and root growth rates, animals, insects, disease, etc.

Growth requirements of reseeded species will not be set up as a separate study. As plot ratings and notes are made upon growth of the various species under different site conditions in present plots, general indications of this phase of the project will be obtained.

Site evaluation or classification will help answer the following questions: (1) Can the site be improved? If so, should it be through management or reseeding? (2) What increase in forage, watershed protection, etc. can be expected from reseeding?

Site evaluation is basic and must be considered every time an area is selected for reseeding. Studies on the indices of site quality and site potentiality should be undertaken as soon as funds permit.

Native vegetation is an efficient indicator of site. Plant growth integrates all site factors and special attention should be given the study of native vegetation to determine reseeding possibilities and to adequately plan for reseeding.

Soil is but one factor in determining growth. As soil is usually reflected in native vegetation, it will be a phase of site quality under the preceding section.

Where mineral deficiencies are indicated, fertilizer application may increase the chances of getting good reseeded stands. Past work shows an increased growth of grass but no greater number of reseeded plants established as the result of nitrogen fertilizer. Until mineral deficiencies are indicated, this is of low priority.

Competition studies. Plants vary widely in their competitive ability. Often seedlings cannot compete with weedy species; but when 1 year or more old, they can hold their own. Studies are needed on competition of seedlings and mature plants of reseeded species with native grass, weeds, and brush. Such studies affect the method of removing vegetation which, in turn, affects seeding costs. Detailed notes should be taken on competition when reseeded plants are involved.

MANAGEMENT OF SEEDED AREAS

Species which do well in row, range, and pilot test plots are suitable for management trials. Management plots should be planted the same as range plots, but the size, species, and replications will depend upon the treatment to be applied.

Grazing management will be simplified if single species are used instead of mixtures. Reseeding is usually undertaken to provide feed during a certain season and, in most cases, a single species will do this better than a mixture and management will be simplified. Where crested wheatgrass is used, best results have come from heavy grazing early in the season with a chance for it to grow during the last part of the growing season.

Reseeded plants are not wonder plants which will withstand unlimited abuse from the seedling stage on. In general, they must be protected for 1 or 2 years, then grazed moderately as native ranges are grazed. There is a possibility, however, that introduced species will withstand heavier grazing than native species. For example, crested wheatgrass has been excessively grazed for hundreds of years in its native land. The surviving plants may be better adapted to heavy grazing than species which have not undergone such heavy usage. This degree of utilization and season of use of introduced grasses needs to be determined.

Wherever reseeded species are grazed, notes should be made of their utilization as compared to native species.

METHODS OF COLLECTING DATA

Summaries, reports, and publications will be easier to prepare and more reliable if the same procedures are used throughout. Therefore, insofar as possible, the following should be standardized: species; methods; plot shape, size, and replication; and most especially, methods of collecting data (see Appendix).

Final yields of grass are more usable if converted to pounds per acre or animal days of grazing. However, production figures are expensive to collect and can sometimes only be obtained as the end product. Therefore, in the interval between seeding and final yields, a system of rating experimental plots has been devised. (See Appendix H and I for instructions on plot ratings and obtaining forage yields on seeded plots.) All counts, ratings, measurements, yields, or other methods of collecting data should be shown in the Working Plan or Study Plan, or reference made to prepared instructions.

METHODS OF DISSEMINATING INFORMATION

Reseeding information is of little value unless applied. Therefore, every opportunity must be taken to make results available.

PUBLICATIONS

One of the best methods of orderly presentation of usable information is publication. There is room for all types of publications and a need for many of them. Every study or group of studies which are established should lead to one or more publications. If studies are properly planned, publications will also be planned and will be easier to write.

To assure that publications are planned and that there is an orderly flow of them, each Working Plan and Study Plan will have a section showing the number and type of publications which will result from the various studies, together with a schedule of when the publications will be completed (see Appendix A and B).

INFORMATION AND EDUCATION

Results can also be disseminated through talks, demonstrations, and show-me trips. Advantage should be taken of all methods, but they should not be carried out to the detriment of current research work and publications.

Centralized work areas provide excellent opportunities for trips to show the reseeding picture from valley floor to mountain top. If seedings are along well-traveled roads and are well described, they are better for demonstrations.

WORKING PLANS

Each research center should prepare a plan of work for artificial revegetation. This plan should show: (1) what is to be done, (2) where it is to be done, (3) how it is to be done, (4) when it is to be done, (5) who will do it, and (6) expected results and publications. All studies contemplated during the period covered by the Working Plan should be listed and outlined with details of how they will be carried out. A short paragraph in the Working Plan should make allowance for opportunistic plots in cooperation with agencies and individuals

The Working Plan does not need to repeat any of the background and justification for studies found in the Problem Analysis. It is merely a plan of work. (See Appendix A for a suggested outline with the list of items to be covered in the Working Plan.) The Working Plan should be approved by the Division Leader and reviewed by the Director and the Washington Office.

STUDY PLANS

As the studies outlined in the Working Plans are initiated, they should be given a title, numbered, and a Study Plan prepared for them. The Study Plan does not need to repeat the Working Plan. The Establishment Report, prepared after the study is initiated, should be a part of the Study Plan. (See Appendixes B, C, and D for a list of items to be covered in the Study Plan and for the system of numbering studies.) Study Plans should be approved by the Division Leader and reviewed by the Director before the study is initiated.

LITERATURE CITED

Some literature on this subject is as follows:

BURTON, GLEN W.
1944. Estimating individual forage plant yields. Journal Am. Soc. Agron. 36: 709-712.

FRISCHKNECHT, NEIL C., and PLUMMER, A. P. A simplified method for determining herbage production and carrying capacity on range and pasture lands (unpublished manuscript).

PECHANEC, J. F., and PICKFORD, G. D.
1937. A weight estimate method for the determination of range or pasture production. Jour. Am. Soc. Agron. 29: 894-904.

PECHANEC, J. F., and STEWART, GEORGE.
1940. Sagebrush grass sampling studies; size and structure of the sampling unit. Jour. Am. Soc. Agron. 32: 669-682. (This is one of several publications by Pechanec on this subject.)

WILM, H. G., COSTELLO, D. F., and KLIPPLE, G. E.
1944. Estimating forage yields by the double sampling methods. Jour. Am. Soc. Agron. 36: 194-203. (Very good for methods.)

REVIEW AND APPROVAL

SUBMITTED A C Hull Jr DATE 2/1/51
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DAVID F. COSTELLO
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W. G. McGINNIES
Director

A P P E N D I X

A. Artificial Revegetation Working Plan Outline

B. Study Plan Outline for Artificial Revegetation

C. Outline for Establishment Report

D. Numbering Artificial Revegetation Studies

E. Symbols for Species Used in Artificial Revegetation

F. Seed Acquisition and Numbering Seed Lots

G. Numbering Artificial Revegetation Plots

H. Instructions for Rating Stands of Seeded Species

I. Herbage Yields of Reseeded Plots

APPENDIX A

ARTIFICIAL REVEGETATION WORKING PLAN OUTLINE
(For Research Centers)

Note: This is a plan of work (1 to 5 years) listing all studies and showing what is to be done, where it is done, how it is done, when it is done, who will do it, and expected results and publications. As studies are initiated, study plans are prepared. (See No. 5 below, and Appendix B). Working plans should not repeat problem analyses. (The form of the outline is not so important if all essentials are adequately covered. However, to follow the same outline will help bring uniformity to the project.)

1. Title. This should identify the problem being studied.

2. Objective or purpose. Brief; the project has already been justified in the Problem Analysis.

3. Literature and past work. Brief; the general state of knowledge has already been covered in the Problem Analysis.

4. Studies that will be needed. List by a descriptive title giving approximate locations.

5. Methods to be used. A general guide on methods and techniques. In most cases the detailed methods will appear in written instructions or in the Study Plans.

   a. Statistical design

      1. Physical layout, plot size, shape, arrangement, replication, randomization, etc.
      2. Variable and constant factors - species, rates, methods, etc.

   b. Field treatments to be applied - methods of seeding, etc.

   c. Data to be collected with dates due.

      1. Ratings and forage yields (see instructions).
      2. Special measurements, counts, etc.

6. Analysis and interpretation of results. Try to anticipate results so that the appropriate analysis and presentation can be planned.

7. Work and report schedule to show duration. Summarization of work and reports with dates due (preferably tabular) to show work load by months and years.

8. Publications. List showing title, probable authorship, date of completion, and where to be published.

9. Responsibility and cooperation.

10. Review and approval. Signatures of author and reviewing officers. (This should have W. O. approval.)

APPENDIX B

STUDY PLAN OUTLINE FOR ARTIFICIAL REVEGETATION

Note: This is a brief, but specific record of work to be done. It should not repeat the working plan. Reference should be made to where this study is outlined in the working plan.

1. Title and number. The code number is helpful in filing, field designation, etc.

2. Purpose. Direct and concise for this study.

3. State of knowledge. Only if not adequately covered in the Working Plan.

4. Location with details of climate, soils, vegetation, history, and other factors not already covered in the Working Plan.

5. Methods.

   a. Statistical design (physical layout, plot shape and size, variable and constant factors, etc.)
   b. Field treatments (seeding methods, etc.)
   c. Data to be collected with dates due.

6. Compilation and analysis.

7. Work and report schedule. Summary of all work and due dates on all reports. This will also show the work load.

8. Publications

9. Responsibility or assignment and cooperation (if not in Working Plan).

10. Tables showing species, treatments, plot numbers, etc.

11. Location map, plot diagram, etc.

12. Establishment report showing date of seeding, conditions at time of seeding, etc.

APPENDIX C

OUTLINE FOR ESTABLISHMENT REPORT

Note: This is a record of what was done as the study was established. It will help explain the success of the study. The arrangement and form of the report is not so important if everything that happens is adequately covered. This is part of the Study Plan.

1. Title (include Study Plan number).

2. Date of establishment.

3. Soil, vegetation, and climatic conditions at time of establishment, including unusual weather or other conditions before or after establishment which may influence the success of the seeding.

4. Field treatments. What machinery was used and how did it work? Were the treatments as expected or were difficulties encountered? Was seed distribution and covering uniform? Etc.

5. Deviations from Study Plan with suggestions as to how future work may be carried out in view of deviations.

6. Tables, maps, diagrams, and photo points not already complete in the Study Plan.

APPENDIX D

NUMBERING ARTIFICIAL REVEGETATION STUDIES

Each study should have a title and a number. The number should show the type of study and the sequence.

The first part of the study number will be a letter designating the line project as follows:

S - Species
M - Methods
F - Site Factors
G - Management of seeded areas

Within each of the above line projects, studies should be given a number in numerical order as they are initiated at each Research Center.

Where a study falls under two or more projects it should be labelled according to the major purpose of the study. A sample list of studies is as follows:

Study No.	Location	No. of Plots	Description	Year Planted
S-1	White River NF	96	12 spp. by 4 methods in sneezeweed	1945
S-2	Crawford	320	Nursery - 80 spp.	1945-8
S-3	Black Mesa	24	12 spp. in plowed weeds	1947
S-4	Crawford	24	12 spp. in plowed weeds	1947
M-1	Black Mesa	32	4 methods of sagebrush eradication	1945-8
M-2	Gunnison	90	6 seasons of seeding for 5 years	1946-50
M-3	Grand Mesa	90	6 seasons of seeding for 5 years	1946-50
G-1	Crawford	12	Grazing Acr and Bin	1945

APPENDIX E

SYMBOLS FOR SPECIES USED IN ARTIFICIAL REVEGETATION

Symbols will save time and space on data sheets and plot diagrams. In reports, the scientific or common names should be used in place of symbols.

All species used for seeding in this region have been listed in alphabetical order with a 3-letter symbol and scientific name. This list is also a basis for planting, seed inventory, summaries, etc. As new species are used for reseeding they will be added to the list in Fort Collins. No symbol should be used until it is cleared in Fort Collins.

To be effective, the symbol list must be followed or the species name written out in full. The use of symbols in place of full names is optional.

A list of symbols for the wheatgrasses most used in reseeding is as follows:

Acr	Agropyron cristatum
Acr - F	Agropyron cristatum (Fairway)
Acr - R	Agropyron cristatum (rhizomatous)
Ada	Agropyron dasystachyum
Aeo	Agropyron elongatum
Ain	Agropyron inerme
Ait	Agropyron intermedium
Asi	Agropyron sibiricum
Asm	Agropyron smithii
Ata	Agropyron trachycaulum
Ati	Agropyron trichophorum

APPENDIX F

SEED ACQUISITION AND NUMBERING SEED LOTS

Seed shortages can best be overcome by anticipating seed needs a year or more in advance. Each winter a seed inventory should be made at each research center. The amount of seed needed for the next field season can be approximated. The list of seed needed with the possibility of local collection and purchase should reach Fort Collins no later than January 1. The project leader will combine requests and will make every effort to obtain the necessary seed. A copy of this list should be retained by the Research Centers for reference. A sample might be:

Species	Needed in 1948	Pounds on hand	Possibility of local purchase or collection	Total Needed 1/
Agropyron cristatum	60	10	45¢ in Delta	50
intermedium	4	0	2 pounds from plots	2
elongatum	3	3	2 pounds from plots	(2)

1/ In addition to amount on hand and amount to be collected.
(-) Seed surplus to this year's needs.

Where seed is obtained from the Soil Conservation Service, it will be necessary to project seed needs three years in advance. This three-year list as sent to the SCS can be revised and confirmed on February 1 in succeeding years. Because the current seed crops cannot ordinarily be harvested, cleaned, and shipped in time for planting that year, seed for planting in 1950 must be ordered in January 1949 for delivery in the late fall of 1949. Below is a sample request to the SCS for seed:

Species	Seed needed (Pounds)		
	1949	1950	1951
Agropyron intermedium	50	50	100
Agropyron trichophorum	5	10	20
Vicia tenufolia	Packet	Packet	5

Seed of most species will retain good viability for three to five or more years, if kept cool and dry. However, it is not recommended that seed for experimental work be kept more than two or three years. Germination tests are best made shortly before planting. In most cases, however, it is more practicable to run germination tests shortly after receipt of the seed (unless germination is already known). If there is a possibility of a change in viability, another test should be run.

Appendix F
(continued)

Seed source can best be traced by giving each lot of seed a number and by following this same number through successive generations, but with a second number added to show progeny. An example follows: Ten pounds of Agropyron intermedium seed was obtained in 1946 and labelled lot #9. This seed was planted in the nursery and in field plots at Manitou. In 1948, seed collected from the nursery plot was designated 9-1, while seed from field plots was 9-2. In 1949, seed from the nursery was 9-3. In this case, 9-1, 9-2, and 9-3 would have the same inherent characteristics, but purity and germination might be different. This system will allow all seed to be traced to the original source and will keep the progeny separated in case of differences in germination, etc.

In strain tests, seed should not be collected in nurseries where two or more strains of the same species are present unless the species is strictly self fertile.

When seed is received, it should be given a lot number (in numerical order by species) on card files at Fort Collins. BPI or SCS strain or accession should appear in parenthesis after our lot number.

Below is a sample 3"x5" seed file card:

Lot No. 9-2 (P-2327) Species Agropyron inerme

Origin Manitou Nursery Date August 14, 1947

Collector Johnson Purity Good

% Germination 91 Date of Test 1/1948

Pounds in stock 6 4.6 2.7 1.8 Closed ✓

Study, date, and amount used

S-7	1948	1.4	S-16	1949	1.8
S-9	1948	1.9			
S-10	1948	0.9			

APPENDIX G

NUMBERING ARTIFICIAL REVEGETATION PLOTS

Within each study, plots should be numbered by the coordinate system. This will simplify locating plots and collecting data. Starting in one corner, the rows should be numbered by steps of 100, i.e., 100, 200, 300, etc. Within each row the plots should be numbered numerically; the first plot in row 100 being 101, the second, 102, etc. A sample of plot numbering with species symbols is as follows:

101 - Acr	201 - Dgl	301 - Bin	401 - Atr
102 - Bin	202 - Atr	302 - Asp	402 - Acr
103 - Ael	203 - Asp	303 - Ain	403 - Bgr
104 - Ppr	204 - Bgr	304 - Pam	404 - Ppr
105 - Ain	205 - Bcu	305 - Ael	405 - Dgl
106 - Asp	206 - Pam	306 - Bcu	406 - Asp

In field application the rows usually run in the direction of the most plots; to give the fewest numbers or rows possible. Where there is only a single row of plots, they can be numbered 1, 2, 3, etc.

APPENDIX H

INSTRUCTIONS FOR RATING STANDS OF SEEDED SPECIES

The final test of any seeded species or method of seeding is the amount of forage produced, the degree to which erosion is controlled, and the ability of the species to maintain itself and spread, under proper use, to adjoining areas. Herbage yields are not a satisfactory measure of stand establishment on row tests, seedling stands, etc. Often the time required to obtain yields is not justified. Thus, some rapid measure of the relative success of stands is needed. Especially during the first years it is necessary to record the success or failure of a seeding.

During early development we need to know the extent and time of germination, numbers of seedlings, seedling mortality, rate of plant development, and other factors which influence the final stand. To insure such notes being in a condensed form and on a comparative uniform basis, a rating system and form has been developed (see attached form). Species should be entered on this form in alphabetical order. An explanation of the form follows:

Relative Rating is the most important entry and is entered last. After observations on plant numbers, distribution, vigor, height, and development have been made, the seeding is viewed as to its present success and rated accordingly. Rating is on the basis of 0 to 10 with 0 indicating failure and 10 full stand of grass on that site. The following adjectives help describe the numerical ratings:

0 - Failure	5 & 6 - Fair
1 & 2 - Very poor	7 & 8 - Good
3 & 4 - Poor	9 & 10 - Excellent

If a seeded area supports the optimum number of evenly distributed plants of that species possible under the existing soil and climatic conditions, this is an excellent stand and rates 10. With seedlings, if enough plants are now present for an excellent stand at maturity, not allowing for mortality, the stand also rates excellent. If the stand is not excellent it is rated with a full number less than 10 down to 0 for a failure. A rating of 5 means that half the plot is occupied by the maximum stand possible of that species on that site. In this case, plants may be all in one-half of the plot or may be scattered over the entire plot area. The relative rating is thus that portion of the plot with enough plants for a full stand.

The rating considers present plants only and does not anticipate mortality or spread by seed or rhizomes. A rating of 10 in a seedling stand indicates enough seedlings for an excellent stand, if all develop normally, but because of seedling mortality this stand might not rate excellent at maturity.

The number of plants required for an excellent stand varies with distribution, species, and site. One plant per square foot might be enough for a full stand if evenly distributed. Two plants per square foot on half of the plot and none on the remaining half averages one per square foot, but because of poor distribution a rating of 5 might result.

Appendix H
(Continued)

Due to different growth habits and size of clumps, Poa bulbosa might require four times as many plants for an excellent stand as Agropyron cristatum. A site with good soil and abundant moisture might support more plants and produce more herbage per square foot than a poor site. The estimator must thus know species characteristics and estimate site productivity when making relative ratings.

To be able to compare results from different areas, relative ratings should be on a uniform basis; both between areas and between individual estimators. Training will be needed to obtain uniformity.

The number of plants per square foot is estimated. It may be necessary to count several samples to arrive at an estimate of the number of plants per square foot. Tenths should be used from 0 to 0.9 and full numbers and tenths above here as needed. On some areas it may be found desirable to stake one or more permanent samples within each plot for seedling counts. These samples would give an indication of plant numbers and seedling mortality. These actual plant numbers should be entered in a special column on the rating form.

Distribution is the evenness with which the plants are spaced over the entire seeding. It is expressed in numbers from one to five as follows: 1 = very poor; 2 = poor; 3 = fair; 4 = good; and 5 = excellent. Distribution must be considered apart from the relative rating. For example, a stand with few plants may be given a low rating of one or two, yet if these plants are evenly spaced over the entire plot, the distribution would be excellent, or 5.

Vigor is the health of the plants as indicated by color, size, etc., at this stage of development for each species. It is expressed numerically as follows: 1 = very poor; 2 = poor; 3 = fair; 4 = good; and 5 = excellent.

Average height is recorded in inches or tenths of inches below one foot and in inches above one foot. Extreme height variations should be noted under "Remarks."

The stage-of-development column is to save space under remarks and to show comparative dates of species development. It is determined by the average conditions of the plants and recorded as follows: S = seedlings; B = boot for grasses, buds for forbs; H = headed out; SR = seed ripe; SS = seed shattered; D = plants dry.

RR - RM
ARTIFICIAL REVEGETATION
Plot rating form

Form RR - 3E
(ACH) 6-1-4C
Rev. 1-3-5C

Location _____ Study _____

Date _____ Examiner _____

Species and Plot No.	Rel. rating 1/	No. of plants 2/	Dis-tri. 3/	Vigor 3/	Av. height (in.)	Dev. stage 4/	Competing spp. spreading habits, mortality, outside influences, etc.

APPENDIX I

HERBAGE YIELDS OF RESEEDED PLOTS

Final data is most useful if it is in pounds of herbage per acre, grazing, or some quantitative measure. Herbage production can be determined by "Weight estimates" or by clipping or by a combination of these two.

Weight estimates are adapted to large areas or where there are many plots of the same species and an individual can train enough to become proficient in estimating. Weight estimates are also necessary where clipping interferes with yields in succeeding years.

Where plots are small, the species varied, and not many yields are being obtained at one time, it is probable that clipping and weighing a few samples is faster and more accurate than training and estimating.

Standardization is needed for obtaining herbage yields, but information is lacking to determine which method should be used. Further work is also needed on number and size of samples. Until a uniform procedure can be adopted, the method of sampling and obtaining herbage production can be decided by the man on the ground, and outlined in the study plan.

For the present it is recommended that clipping be used on small plots of different species, and that clipping and weight estimates (double sampling) be used on large areas or on many plots of one species.